TECHNOLOGY SPECIAL REPORT RESEARCH AND

on the

NASA PROGRAM

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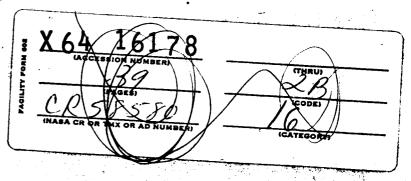
HUMAN FACTORS AND BIOSCIENCES

and the

ASSOCIATED PHASES OF THESE PROGRAMS

in the

MANNED SPACECRAFT SYSTEMS PROGRAM



An Extraction From: Research and Technology Program Digest FY 63

PROGRAMMATIC LISTING OF TASKS BY THE FOLLOWING PROGRAMS AND SUB-PROGRAMS

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SUB-PROGRAMS

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77 HUMAN FACTORS SYSTEMS PROGRAM 770 Director of Biotechnology and Human Research

49 Human Performance & Behavior Sub-program

OT PERCEPTION TASK AREA

21-77-770-100-49-01-01 | Neurohormonal Studies as Related to Space Flight Stresses

Neurohormonal aspects of brain mechanisms and stress. (1) To Identify the neurohormone from the hypothalamus which releases ACTH from the pituitary. Evidence so far indicates that this is Vasopressin (ADH). (2) To assay Vasopressin in brain tissue, in jugular blood and in C-S fluid in animals under various physiological and "unphysiological" conditions such as physical and psychological stresses. (3) To investigate the mechanisms by which Vasopressin is

released from the hypothalamus under stress and role of Vasopressin in the synthesis and degradation of ACTH (with Dr. Stanley Ellis). (4) To measure adrenal steroids and catecholamines in blood and urine in animals and man under stress

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21-77-770-100-49-01-02 Pituitary Chemistry

To determine the nature of the chemical and physiological mechanisms responsible for the bio-synthesis, storage and secretion of pituitary hormone with particular reference to the effects of stresses such as may be encountered during manned space flights.

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10-77-770-100-49-01-03 Respiratory

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To determine the optimum space cabin environment and the hazards resulting from variations in environmental gas concentrations.

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21-77-770-100-49-01-03 Research in Cerebral Neurophysiology and its Applications in Monitoring Behavioral States —Ames

To pursue cerebral neurophysiological studies including (1) the feasibility of placing recording electrodes in deep brain structures, (2) effects of vibrational stresses on brain electrical activity, (3) studies of cosmic ray effects on brain electrical activity, (4) chimpanzee neurophysiological and behavioral studies, (5) application of EEG recording to manned space flight, and (6) computer studies of EEG data.

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10-77-770-100-49-01-05 Central Nervous Systam

-Hdat To partially fund the National Academy of Sciences, National Research Council, Committees on Vision and on Hearing and Bio-Acoustics.

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10-77-770-100-49-01-06 Central Nervous Systems

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To conduct a neurophysiological analysis of the "electro-narcosis" phenomena with the aim of understanding the mechanisms for the physiological manipulation of consciousness.

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77 HUMAN FACTORS SYSTEMS PROGRAM 770 Director of Biotechnology and Human Research 49 Human Performance & Behavior Sub-program

01 PERCEPTION TASK AREA

10-77-770-100-49-01-07 Central Kervous System

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Study the basic physiological mechanisms which defined the human body against heat and cold, and to determine the extent and efficiency of energy transformation in the human body and in isolated body constituents at the molecular level.

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10-77-770-100-49-01-08 Central Nervous System

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To obtain data on the variables that affect the threshold for thermal sensations at skin temperatures between 27° and 42°C, and to study the relationship between skin temperature, thermal threshold, and state of vasoconstriction.

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10-77-770-100-49-01-09 Gastrointestinal and Metabolic

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The precise caloric, protein, and water requirements will be studied in 16 young male individuals per year. Individual amino acid, caloric, and water requirements will be studied under controlled baseline conditions. Altered requirements due to changes in pressure, temperature, activity, and the wearing of a full pressure suit will be studied using the AMRL Space Vehicle Environment Simulator.

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10-77-770-100-49-01-10 Endocrine

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To determine the effects of chronic hypoxia, cold, exercise, and stress upon erythropoiesis and adrenal cortical function during ascent of Mount Everest.

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02 ENVIRONMENTAL PHYSIOLOGY TASK AREA

10-77-770-100-49-02-01 Ion Effects on Man

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Analyze the existing experimental data on man and animals to determine the effects of positive and negative ions in order to either write habitability requirements for prolonged confinement in space cabins or indicate avenues of research that must be pursued in order to determine adequate design criteria.

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21-77-770-100-49-02-01 Vision, Circulation and Respiration under Sustained Acceleration —Amer

Sustained linear acceleration regardless of how applied to the body affects adversely the function of the respiratory, cardiovascular and visual systems in the body. Past investigations have delineated the nature of these effects. It is necessary to further investigate more specifically the character

and magnitude of these adverse effects in order to determine the ideal physical orientation of the pilot in relation to the motion of a vehicle so as to permit the optimum physiological performance.

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To analyze the role and function of the vestibular canals and in particular to study the relationships between rotational stimulation of the labyrinth and the variables of circulation and respiration.

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21-77-770-100-49-02-02 Study of Long-Term Effects of Low G-loading on Mammals (mice, rats, etc.)

To study the effects of long-term exposure to an altered G environment (by centrifugation) of various mammals including mice, rats. Physiologic and biochemical effects will be measured to delineate those responses which are G-responsive. Control data as well as test animal data will ultimately be applied to setting up specific experiments for sustained zero G studies. Adaptive

changes in the homeostatic processes will be followed in supra one G adapted animals when they are returned to normal G environment. Intracellular effects of sustained G loading will be studied particularly changes in fat and carbohydrate metabolism of mitochondria and protein metabolism of isolated microsomal fractions. Alterations in blood and tissue isoenzymes will be studied. Metabolic studies both at the whole animal level as well as the tissue and cellular levels will be followed with labeled substrates.

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10-77-770-100-49-02-03 Acceleration

To take the existing information both analytical and research, and summarize all the acceleration effects; that is, including positive, negative, high-G, random-G (tumbling) and acoustics (vibration and noise), and their effects on man in order to determine design criteria, as well as to point out effects of research required to answer problem areas for future aerospace vehicles

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21-77-770-100-49-02-03 Metabolism of Animals as Influenced by Space Environmental Conditions

The purpose of this research is to undertake a study of the total body metabolism of mammals under conditions which simulate prolonged space voyages to determine whether environmental conditions encountered alter the normal pattern.

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10-77-770-100-49-02-04 Acceleration

To determine the mechanisms by which force fields will produce disorientation and functional disturbances by their effects upon the semi circular canals and otolith organs of the inner ear. Normal and altered vestibular function will be studied.

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21-77-770-100-49-02-04 Radiation Doslmetry and Measurement To develop techniques and devices which will improve the basic understanding of the interaction of radiation with living organisms and provide optimum design criteria for satellite instrumentation.

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10-77-770-100-49-02-05 Radiation

Contractor will develop a technique for calibration of different types of radiation on a scale showing dose vs. cell destruction. It is planned to establish a common unit (Linear Energy Transfer) as an index of cell destruction (various radiations will show various LET's). Study is effected to provide a unifying indicator for radiation damage for a mixed or pure spectrum. A prime objective appears to be fabrication of instrumentation that will measure the absorbed dose within a scattering medium of yeast cells.

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21-77-770-100-49-02-05 Theoretical Study of High Energy Radiations in Relation to Biological Systems

Physical characteristics of high energy radiations in space will be compared to those of man-made radiations in order to predict equivalent biological changes. Tolerance limits of the central nervous system for heavy cosmic ray primaries will be estimated and related to other deleterious effects which may be mitigated by drugs or local shielding.

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77 HUMAN FACTORS SYSTEMS PROGRAM 770 Director of Biotechnology and Human Research 49 Human Performance & Behavior Sub-program

02 ENVIRONMENTAL PHYSIOLOGY TASK AREA

10-77-770-100-49-02-06 Radiation

1. Study biological effects of 730 Mev protons (184-inch cyclotron). 2. Study biological effects of heavy ions up to 30 Mev per nucleon (88" cyo). 3. Study proton and other heavy ion interactions with potential shield materials and other spacecraft components. 4. Basic molecular and cellular effects of accelerated particles.

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21-77-770-100-49-02-08 Effects of High & Loading on Metabolism To determine the effects of high G-loading on the metabalism of mice.

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10-77-770-100-49-02-07 Radiation

1. Species correlation, principally mammalian, of biological effects of high energy proton irradiation, partial and whole body. Work to be compared with previous studies using neutron, x- and gamma radiation. 2. Calculate RAD and REM doses in human phantoms as a function of radiation energy. 3. Determine physical parameters which may be correlated with biological damage. 4. Develop practical physical methods to measure radiation hazard to man and biological systems.

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21-77-770-100-48-02-07 Pathological Studies on the Brains of Mice and One Monkey to be Exposed to Cosmic Radiation in High Altitude Balloon Flights

Extension of Project R-26: To cover cost of serially sectioning the brains of the increased number of animals flown in balloon flights on eriginal project. This means processing and analyzing 90,000 more histological slides than was previously covered in the initial statement.

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10-77-770-100-49-02-03 Radiation

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To determine the energy dissipation characteristics in tissue for lonizing radiation in space.

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21-77-770-100-49-02-08 Space Physiology (Extension of HsS 139-61) -Ames To establish base-line data on physiological parameters of function in mammals under conditions which simulate those to be found within a vehicle in interplanetary flight.

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10-77-770-100-49-02-09 Predominating Fecal Flora in Man

To utilize an anaerobic technique to isolate intestinal flora bacteria, in subjects that are under normal conditions and subsequently placed in space flight environments. The study will evaluate the influence of space conditions on the balance of man's intestinal flora and man's reaction to any change in this balance.

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21-77-770-100-49-02-09 Histeopathological Study of the Effect of Fission Fragments on the Central Nervous System and Selected Organs (NAS 2-1336) —Ames

To study the biological effects of energetic, massive, highly charged particles on rats. The cosmic particles will be simulated by fission fragments actually generated within the bodies of the rats. The cellular effects of the fission fragments will be studied histopathologically. The toxicity of community of the studied histopathologically. pounds containing uranium and plutanium will also be determined.

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10-77-770-100-49-02-10 Non-lonizing Energy Fields

To analyze the existing animal and human data in high, low, and nul magnetic fields for application to design of manned space systems and to point out possible human research requirements if magnetic field effects are not sufficiently understood and documented. This study will be coordinated with the present study on magnetic fields on animals sponsored by NASA Biosciences, and with current work being conducted by the Atomic Energy Commission and other agencies. To determine the effects and precautions required for life In environments containing abnormal levels of non-ionizing energy such as ultra frequency, radio frequency energy and light (laser emission, etc.).

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21-77-770-100-49-02-10 Parametric Study of Flight-induced Pulmonary Pathology

A series of experiments will to conducted for determin-A series of experiments will be conducted for determining the environmental conditions associated with the sulmonary pathology observed in pilots of high-performance aircraft. Selected human subjects will be centrifuged through an analogue of the Apollo reentry g profile, while systematic variations of the following parameters are imposed: breathing gas pressure; breathing gas composition; and the duration and direction of g-loads. Sufficient

measures will be employed to describe the physiological condition of each subject during the experiments. Resulting data will be analyzed to determine the conditions that induce pulmonary pathology, and the physiological changes that induce, or are associated with the onset of the pathological response.

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10-77-770-100-49-02-11 Non-lonizing Energy Fields To study the effects of high and low magnetic fields on animals and human beings.

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21-77-770-100-49-02-11 Electroneurophysiological—Task Performance Correlates

An experimental investigation of variations of the electroneurophysiological correlates and task-performance under conditions of controlled stimuli. It is planned to use both pigtail monkeys and chimpanzees.

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10-77-770-100-48-02-12 Atmospheric Conditions Determination of the possible neuropathological effects of prolonged exposure of rabbits and mice to a 100 per cent oxygen atmosphere.

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21-77-770-100-49-02-12 Biological Research with Heavy Ion Beams Biological Research with Heavy Ion Beams.

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10-77-770-100-49-02-13 Atmospheric Conditions Study of the metabolic, biochemical, biophysical, and histologic characteristics of oxygen toxicity in isolated tissues of animals exposed to 100 per cent oxygen at atmospheric pressures varying from 7.4 psi to 14.7 psi.

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21-77-770-100-49-02-13 Dosimetry of High Energy Radiation Dosimetry of High Energy Radiation.

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10-77-770-100-49-02-14 Atmospheric Conditions -Hdqt To study the hematological and hematopoletic effects of a 100 per cent oxygen environment.

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77 HUMAN FACTORS SYSTEMS PROGRAM 770 Director of Biotechnology and Human Research 49 Human Performance & Behavior Sub-program

21-77-770-100-49-02-14 Post-Mortem Clinical Analysis of Biological Specimens —Ames

Post-mortem chemical analysis of biological material will be undertaken to establish the ante-mortem status of individuals in closed space systems. New biochemical methods and techniques will be developed for this purpose.

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10-77-770-100-49-02-15 Radiation

This project is a continuation of ten-year observations on some 475 irradiated and 104 control primates throughout the remainder of the primate's life for long term effects studies in cataractogenesis, longevity, and carcinogenesis.

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10-77-770-100-49-02-18 Radiation

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1. Measurements of dose and depth dose distribution produced by protons of various energies. 2. Determination of effects of proton irradiation in animals. 3. Provide dosimetry for proton irradiation of biological samples. 4. Calibrate solid-state detectors for future use as active dosimeters.

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10-77-770-100-49-02-17 Radiation

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To study the modification of ionizing radiation effects in primates with transfusions of the specific blood cell types in Hematopoietic tissue.

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10-77-770-100-49-02-18 Acceleration

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To investigate the interacting effects of hydrostatic pressure and low temperature upon the reanimation of infant and adult mammals in hypothermic suspended animation after removal of the gas phase. This will be carried out in a static hydraulic pressure chamber to remove the complicating effect of acceleration as reported in the preliminary study. The additional effect of acceleration will then be studied in the centrifuge.

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10-77-770-100-49-02-19 Environmental Physiology

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1. Study biological effects of 160 Mev protons, principally on neurological tissues, with emphasis on the brain. 2. Study proton interactions with potential shield materials and other spacecraft components. 3. Basic molecular and cellular effects of 160 Mev accelerated particles. This task will be closely coordinated with HQ and AEC.

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10-77-770-100-49-02-20 Radiation

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1. Ascertain if carcinogenesis will result from exposure to either cosmic radiation and/or the Van Allen radiation belts. 2. Improve predictions concerning hazards of space travel.

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10-77-770-100-49-02-21 Free Space—Extravehicular and Surface Environmental Studies —Hdqt

1. Establish base line data on physiological parameters of high level mammalian organisms under conditions corresponding as closely as possible to those in a flight vehicle in the interplanetary environment. 2. Development of sensors to accomplish #1 above. 3. Dev. of prototype device for com-

pletely isolated holding (with minimum restraint, and remote observation) of animals as though they were in space. 4. Establishment of new studies in chamistry and physical level of Biology.

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formance of an observer will be measured under	Using simulator doing tasks perti	r setups which	ch provide v altitude su	motion, irveillance	the per- mission	·	NEW	FY 63 Main Yes	Prof	el work	Tel	•
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77 HUMAN FACTORS SYSTEMS PROGRAM 770 Director of Biotechnology and Human Research 49 Human Performance & Behavior Sub-program

04 PSYCHO-PHYSIOLOGY AND BEHAVIODRAL SCIENCES TASK AREA

21-77-770-100-49-04-02

Visual Perception Burlag Space Missions

Work performed under this task will (1) dotermine visual requirements of space system operation (FY '63), (2) identify potential problems of visual perception due to anticipated mission conditions (FY '63) and (3) perform research to solve these problems (FY '63-64). Laboratory methods and ground-based simulators will be employed to provide needed information concerning basic visual processes, to specify man's capabilities and limitations, and to develop and evaluate space system hardware (including information displays) which involve

the visual process. Where appropriate, experiments will be developed to be conducted under actual space operating conditions. Contracts (contractor not yet determined) will be awarded to study specialized aspects of visual performance.

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23-77-770-100-49-04-02 Determination of Visual Aculty

To determine visual acuity with regard to such tasks as

depth perception, closure rate perception, angular rate perception, target acquisition, etc., with regard to such space operations as rendezvous, docking, lunar landing, etc.

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10-77-770-100-49-04-03 Cerebral Mechanisms

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To develop techniques for the recording of brain wave activity in primates during space simulation stresses, including techniques for deep and surface electrode implantation, the establishment of EEG baselines for various physiological states, and techniques for data reduction and analysis.

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21-77-770-100-49-04-03 Decision Making in Space System Operation

Work performed under this task will (1) determine requirements for judgments and decisions associated with space system operation
(FY '63), (2) identify potential problems related to the operation of such systems
(FY '63), and (3) perform research pertinent to the solution of these problems
(FY '63-64). Determination will be made of man's capabilities in responding both
to the ordinary and to unexpected events of space missions. Both laboratory
methods, and ground-based simulators will be used. Where appropriate, research

will be conducted under actual space system operating conditions. Contracts contractor not yet determined will be awarded to study specialized aspects of the decision-making process.

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10-77-770-100-49-04-04 Cerebral Mechanisms

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To develop techniques for the recording and analysis of brain wave activity in primates during space simulation stresses. The scope of the work includes development of implantation methods for surface and for deep electrodes, the establishment of baseline data for EEG in the primates in all normal states including emotional arousal, application of data reduction techniques

to the EEG recordings, including computer analysis. The project aims ultimately at the utilization of EEG as a measure of the ability of a primate or a man to perform under conditions of space travel.

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23-77-770-100-49-05-01 Examination of Methods f. Simul...ing Zere "C" — LRC

To develop devices for creating the sensations of zero "g" for relatively long periods of time (one hour or more) and to study man's ability to perform tasks under these conditions.

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23-77-770-100-49-05-02 Human Behavior and Performance During Simulated Long Duration Missions —LRC

To study crew behavior performance under conditions simulating long-duration space missions with the objective of avoiding any deleterious effects.

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51 Physical Biology Sub-program

OT BIOCHEMICALS TASK AREA

10-77-770-100-51-01-01 Effects of Isolation, Sensory Deprivation & Sensory Rearrangement —Hdqi

The investigator will study the effects of sensory rearrangement, specific sensory deprivation & Isolation factors on basic sensory thresholds, including the analysis of evoked potentials & physiological indices (EEG, EKG, GSR, etc.).

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21-77-770-100-51-01-01 Skilled Performance in Space Vehicle Control —Am

Work performed under this task will (1) determine requirements placed upon the space system operator for complex motor skills performances (FY '63), (2) identify potential problems related to the operation of systems requiring such skills (FY '63), and (3) perform research pertinent to the development of maximally effective systems (FY '63-64). Both laboratory methods, and ground-based simulators will be employed. Where appropriate, research will

be conducted under actual space system operating conditions. Contracts (contractor not yet determined) will be awarded to study specialized aspects of skilled performance.

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10-77-770-100-51-01-02 Handbooks of Human Factors Methods

The contractor will provide a study to determine the requirements and methodology for human factors system engineering and design for aerospace systems, manned and unmanned.

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21-77-770-100-51-01-02 Communication in Space Operations

Work performed under this task will determine requirements for, and anticipated problems of communication within the space environment, and among launch crews on earth. A mathematical approach will be employed evaluating systems in use and specifying adequate communication systems for future use in accordance with both mission requirements and human capabilities. The adequacy of communication systems in task performance will be made in the

laboratory, under simulated operating conditions, and in the actual operational environment when this is desirable and possible. Contracts (contractor not yet determined) will supplement in-house work in specialized areas of communications research.

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10-77-770-100-51-01-03 Biological Mechanisms

To review biological mechanisms for application to instrument design. The cost increase resulted from an increase in overhead rates from 165% to 180% and a G&A rate of 12.5%.

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21-77-770-100-51-01-03 Pilot's Ability to Cope with Sudden Changes in the Controlled Element

To determine the ability of the pilot to cope with or adapt to abrupt changes in stability and damping such as stability augmenter failures; abrupt changes in information input, specifically transition from IFR to VFR and from normal to emergency display modes; and abrupt changes in control behavior, i.e., engine or power control failure and/or control surface damage. These

situations will be created on motion simulators and in Tilgir with variable-stabil aircraft to determine how the pilot adapts and what the quantitative limits his abilities are.

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10-77-770-100-51-01-04 Characteristics of the Segments of the Human Bod

For more accurate anatomical information in developm of restraint and protective systems, the investigators will determine mass, dens and center of gravity of 15 definitive body segments in 12 cadavers anthropon rically comparable to the Air Force flying population.

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21-77-770-100-51-01-04 Application of Reliability Theory to the Allocation Function Between the Pilot and the Vehicle Systems—Allocation Function Func

To develop analytical and experimental means for de mining the reliability of competing manual and automatic control systems mid-course and re-entry control of space vehicles. Procedures will then be de oped for using these determinations to assess the optimum allocation of con

function between the crew and the vehicle systems and to assess the increase probability of mission success resulting from full use of the crews' control, m toring and decision-making abilities.

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10-77-770-100-51-01-05 Biological Mechanisms

Additional funds required to cover increase in over since execution of original contract.

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77 HUMAN FACTORS SYSTEMS PROGRAM 770 Director of Biotechnology and Human Research 51 Physical Biology Sub-program

01 SIOCHEMICALS TASK AREA

21-77-770-100-51-01-05 Problem Areas Associated with Flight Through Turbutent Air -- Ames

To consider the following aspects of flight through turbulent air, specifically the A2F, TFX, and SST mission profiles: (a) Control system feel requirements, stability augmentation, gust alleviation; (b) Crew station design, including restraint; (c) Display requirements; (d) Long-term effects on pilot and

crew performance; (e) Passive passenger comfort and tolerance levels and (f) Simulator requirements. Motion simulators and an A2F will be used in conjunction with the NAA simulator.

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21-77-770-100-51-01-06 Vestibular Motion Cues Used by the Human Pilot --- Ames

Thresholds and reaction latencies for perception of angular motion have been measured on Ames test pilots to limits feasible on existing 5°-of-freedom device. Specifications for more sensitive equipment have been prepared. Tests will be repeated on this, on Ames Space Flight Guidance Facility to determine effects of steady acceleration (1965) and in actual flight to determine effects of environment and combined unlimited maneuvers (1964-5). Thresholds

and characteristics of visual perception of motion will also be determined to see how it relates to the vestibular functions. The effects of combined inputs and emergency stresses on recognition and latency will also be determined.

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21-77-770-100-51-01-07 Human Pilot Control Problems in a Manned Planetary Landing

By piloted simulations and flight tests to determine the proper function of the human operator in a planetary landing system (atmospheric); to determine what characteristics should be built into the vehicle and its system for optimum performance and reliability; to determine requirements for adequate research and training simulators.

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21-77-770-100-51-01-08 Besign Principles for Display and Control Systems for Recovery from Unusual Attitudes — Ames

To set up design principles aimed at providing increased pilot's capability in affecting recovery from unusual attitudes brought about by post-stall gyrations, transition from VFR to IFR flight (business aircraft) and lateral-directional cross-coupling. Possible use of alternative inputs such as display quickening, integrated director displays, aural and tactile input devices will be considered.

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21-77-770-100-51-01-09 Human Pilot Control Problems in a Manual Abort of a Lunar or Planetary Mission —Ames

By analytical studies and piloted simulations to consider feasible control and navigation techniques under likely abort conditions; to determine optimum allocation of function between pilot and vehicle systems for reliability and performance; to determine requirements for adequate research and training simulation.

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21-77-770-100-51-01-10 Effects of Individual Environmental Stresses of Space Flight on Human Pilot Performance —Ames

To use closed-loop simulations with a human pilot placed in various NASA and DOD single-purpose environmental stress facilities to determine the effects on human performance of linear acceleration; short term weightlessness, vibration, impact, heat, pressure, and crew space habitability. A standard pilot task is used on centrifuges, Daisy track, heat and vacuum chambers, vibration device at WADD, and so forth.

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21-77-770-100-51-01-11 Biological Control Systems—A Comprehensive and Critical Review of the Field ——Ames

To make a comprehensive review of the current state-of-knowledge in the field of biological control system. Raview will include (1) appraisal of experimental programs, (2) evaluation of the state-of-engineering, and (3) discussion of the potential applicability of knowledge gained.

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21-77-770-100-51-01-12 Utilization of Bioelectric Parantials. Support Phase 1

To establish the feasibility of the utilization of the Bioelectric Potentials as a primary energy source for insuanted electronic devices.

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02 INFORMATION ACQUISITION TASK AREA

10-77-770-100-51-02-01 M-MIC

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To cover the cost of operation of the Man-Machine Information Center for one year.

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21-77-770-100-51-02-01 Operator Selection for Space Missions

Work performed under this task will develop methods for selecting individuals for the performance of space missions. Man's activities in space system operation, and the conditions under which performance will occur, will be analyzed to determine requirements to be satisfied by the selection procedure. Methods of selection will be developed. Tests of man's response to conditions expected in space system operation (including inter-personal inter-

actions) will be made in laboratory facilities and in ground-based simulators. Where appropriate, research will be conducted under actual space system operating conditions.

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23-77-770-100-51-02-01 One-Man Vehicular Locomotion

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To study the system requirements and pilot ability to control and navigate himself under zero gravity as in operations between and about orbiting vehicles. Analytical studies and simulations will be performed. The problem of rescue will also be studied as a special case.

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93 CONTROLS & OPERATIONS TASK AREA

10-77-770-100-51-03-01 Remote Control Systems

—Hda

To determine the role of remotely controlled systems in future space missions, to define the various configurations such systems might take, and to recommend the development of advanced technology which can be utilized in the selection of specific systems for particular missions.

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21-77-770-100-51-03-01 Development of Physiological Montioring Equipment for

Use in Motion Flight Simulators and Aircraft
To provide medical monitoring equipment for the motion
flight simulators at the Ames Research Center, and for use in aircraft such as the

flight simulators at the Ames Research Center, and for use in aircraft such as the F160C at the Flight Research Center and a back-up system for the X-15 aircraft. This program will permit refinement of the currently string equipment with a view towards its being ultimately available for erbiting and space vehicles. A letter of request from FRC to ARC dated 10/27/61 requests this equipment.

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24-77-770-100-51-03-01 Crew-Aircraft Integration

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The objective of this task is to investigate the effect of mission requirements, crew number, and environment upon crew-aircraft integration.

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The contractor will review contemplated manned space missions subsequent to Apollo and establish a generalized mission envelope to serve as a basis for the design.

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21-77-770-100-51-03-02 Piloted Simulator Requirements for Effective Research, Development, and Training —Ames

To synthesize the available information on physiological sensors, cues used in actual flight, and comparisons between flight and all classes of simulator in order to develop a rational approach to difining simulator requirements for a given vehicle and system.

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10-77-770-100-51-03-03 Advanced Integrated Display & Control Systems — Hd:
To cover increased overhead costs.

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77 HUMAN FACTORS SYSTEMS PROGRAM 770 Director of Biotechnology and Human Research 51 Physical Biology Sub-program

03 CONTROLS & OPERATIONS TASK AREA

23-77-770-103-51-03-03 Extermination of Pilot Dynamic Characteristics — LRC To study pilot's dynamic characteristics under actual and simulated flight conditions in order to find an objective measurement of performance and a mathematical description of the pilot in man-machine systems.

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53 Life Support Sub-program

01 ATMOSPHERE CONTROL TASK AREA

10-77-770-100-53-01-01 Photosynthetic Eas Exchanger —Hdqt
To use a photosynthetic gas exchanger in a scaled, manned capsule to convert carbon dioxida into oxygen, and to recover and reuse non-carbon dioxida wastes.

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21-77-770-103-53-01-01 Heat Regulation at Reduced Pressures

It is the objective of this task to determine the characteristics of heat regulation at reduced atmospheric pressures. The investigation will be performed in an environmental vacuum chamber. The chamber will provide the means for radiative heat losses from an individual by varying the chamber wall temperature. Evaporative and convective cooling will be investigated under various conditions of atmosphere circulation rates and humidity.

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23-77-770-103-53-01-01 Development of Life Support Systems

To evaluate components of a life support system, and assess overall suitability of components as part of a total life support system. Work is in progress on evaluation of CO_2 removal system and H_2O reclamation system. Work with these components will extend to complete systems.

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10-77-770-100-00-91-02 Electrolyte Crygon Enterator —Hdgt To design, fabricate and test 2 types of cells using PaOs for removing water from the air and electrolysis to dissociate the water to Dreathable oxygen.

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21-77-770-103-53-01-02 Raganerative Characteristics of Adsorbers Used in Environmental Control Systems —Amos

This study will basically evolve first a determination of the toxic elements in closed environmental systems. Methods of detecting these elements will have to be devised. At this time the study will proceed into the phase of determining the regenerative characteristics of chemical and other

adsorbers which will best remove these toxic elements. The study will also investigate the effects that heat, vacuum and package configuration have on these adsorbers.

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23-77-779-160-53-01-02 Integrated Advanced Life Support System

Perform the advanced research and technology required in the proof of concept of an advanced life support system that includes a following aspects: environmental and atmospheric control, food and water, and hygienic and sanitation criteria.

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10-77-770-100-53-01-03 Parameters Essential for Manned Flight Operation —Hdqt

To investigate parameters essential for Manned Flight
Operation. (Elevated CO₂ concentration, water loss of man, effects of 100% O₂,
gas rate of exchange in a sealed space cabin, gas chromatography, analysis of
trace atmospheric contaminants).

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21-77-770-100-53-01-03 Clased Life Support System Optimization Studies — Ame
it is the purpose of this task to perform optimization studies on life support systems. Evaluation will be tasked on massion duration system weights, and power requirements. Consideration will be given to chemic and biological means of life support management.

10-77-770-100-53-01-04 Integrated Ruman Maintenance Subsystam The contractor will design, fabricate and test the following complete environmental subsystem in a Humidity and temperature controlled chamber: 1) Respirator System; 2) Waste handling system; 3) water recovery system; 4) food supply; 5) wash water system.

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21-77-770-100-53-01-04 Effects of High Oxygen Tensions on Central Mervous

To study the effects of high oxygen tensions on the central nervous system by studying the effects of O_2 on the structure of cell and tissue membranes.

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10-77-770-100-53-01-05 CO. Reduction System -Reat Contractor will design, fabricate and operate an open cycle carbon dioxide reduction unit.

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10-77-770-100-53-01-08 Use of Czonides for Air Revitalization -Hdat

Contractor will optimize the processes for the synthesis of low molecular weight alkali metal ozonides as to purity, yield, and stability; and shall conduct studies of the initiation and control of reactions between ozonides and water vapor, thermal stabilities, and decomposition products as well as heats of reaction and melting point temperatures.

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10-77-770-103-53-61-07 Metallic Superoxides

--Hdat The contractor shall prepare design drawings of an engineering model micro-contractor that will utilize high density metallic superoxides to revitalize sealed cabin breathing atmospheres, and, after approval, will fabricate and test the system.

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03 WASTE DISPOSAL TASK AREA

10-77-770-100-53-03-01 Bioelectrochemistry

__Hdc To study fundamental bio-electrochemistry (by Ford), applied bio-electrochemistry (by Magna), and to develop a biochemical fuel cell (marquardt).

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21-77-770-100-53-03-01 Design Construction and Test of an Integrated Huma Maintenance Subsystem

To undertake a program of studies leading to the design fabrication, and test of an integrated system capable of providing adequate lif support for five men for a thirty-day period.

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77 HUMAN FACTORS SYSTEMS PROGRAM 770 Director of Diotechnology and Human Research 53 Life Support Sub-program

04 PROTECTIVE DEVICES TASK AREA

21-77-770-100-53-64-01 Improvement of the Ames Support and Restraint Syntom

Modifications of the Ames Physical Support and Restraint System in order to improve this system are necessary in order to increase the scape of its use from present motion flight simulators to a flight article. These include reduction in weight and bulk, botter articulation and integration of this article with the full pressure suit. It is also desired to study its impact capability.

Testing would have to be conducted at such facilities as the Dalsy Track, Holomon AFB, the Import Acceleration Davice Aero Med Laboratory, Wright-Potterson AFB, Obie and the Johnsville Contribute.

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21-77-776-103-53-64-02 Anthrepometric Devices for Planetary Exploration —Amos

The objective of this task is to conduct investigations that will lead to the specifications required for anthropometric devices needed in planetary exploration by defining the environment as well as possible methods of solution to the problems posed.

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05 SYSTEMS STUDIES TASK AREA

10-77-770-100-53-05-01 Milatatorized TV Comera

To conduct a design study, design, febricate, & test and deliver a miniaturized TV comera with a solf contained power source and requiring no interconnecting cables between the TV camera and monitor.

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06 BIOENGINEERING TASK AREA

10-77-770-100-55-00-01 | Dis-Disetregenosis

in a Clasicatrogenic System: 1) To study the mechanisms by which the energy is preceive; 2) To verify the role of metabolities in production of energy; 3) Salation of preceived organisms to produce optimum output; 4) Measure and computation of Faradaic Efficiency; 5) To study 4 culest optimum membrane & electrode system; 6) Assembly & test of optimum Bio-Electrogenic System.

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21-77-770-103-53-03-01 Arterial Pulsa Prossure Ear Oximator Telematry —Amas
To provide a transducer with a telemater system for the

measurement of blood oxygen saturation and some indication of relative changes in arterial blood pressure for use on motion flight simulators, aircraft, and laboratory exercise equipment.

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24-77-778-163-83-63-31 Poyshophysisis gisal Information Acquisition Processis and Control System (PMPAGS) —FR

To advance the state of the art in biotechnology as human research by procuring a Psychophysiological Information Acquisition Processing and Control System (PIAPACS). To maintain, operate and modify PIAPAC as required to conduct experiments to yield information vital to life and processing and processing and processing and processing and processing are processed by the processing and processing and processing are processed by the process

tective systems as applicable to laboratory, simulator and In-flight regimens f determination of the man-machine-environment interrelationship. This task w be coordinated with Hq.

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10-77-770-100-53-08-02 Photosyntholic Gos Exchanger
To modify the existing photosynthetic gas exchanger a operate it in extended factorial experiment and under established optimum contions using recycled medium supplemented with processed human waste; des

tions using recycled medium supplemented with processed human waste; design and fabricate two ten-liter fermentor vessels and a suitably sized primate chamber and an intermediate carbon dioxide concentrator for closed cycle operation with modified exchanger for future studies; conduct booteriological analyses algae cultures and growth studies at high intensity with selected algae strain

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21-77-778-103-53-08-92 Study and Evaluation of Psychophysiological Monitorin Techniques for Usa in Advanced Acrospace Missions

Work performed under this task will be concerned wi monitoring human physiological responses as a function of various environment conditions expected on advanced aerospace missions. Techniques will be develope to permit continuous monitoring while subjects are engaged in the performance

of mission tasks under a high degree of simulation of actual mission condition. Of primary interest will be such measures as EEO, EVID, OCI 2 of respiratory as circulatory measures under such stresses as experient of acceptable things at zero-GD and reduced sensory input. An integral part of the check put ons will a succeptable to improve the techniques of analysis of such data by equial compute matheds.

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1) Chronic and continuous measurement of blood flow;
2) Chronic and continuous measurement of intracordiae and intervascular pressure;
3) Continuous measurement of oxygen saturation of arterial and vanous blood in intect corta and pulmonary artery; 4) implantation techniques for resistance to time, vibration and gravitational stresses.

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21-77-770-103-53-05-03 Diological Dosign Studies of Man —Amas

A study of man in an extraterrestrial environment, concerned with the system requirements for the optimum spacecraft configuration

cerned with the system requirements for the optimum spacecraft configuration design which will insure the safety and continued contribution of man to extraterrestrial and space explorations.

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07 PERSONNEL EQUIPMENT TASK AREA

10-77-770-103-53-07-01 Evaluation of Control Display Parameters —Hdqt
An evaluation of control display parameters by measures
of human performance during positive transverse acceleration will be made by
means of experiments on the human centrifuge and the simulation of flight control
display dynamics using analog techniques.

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24-77-770-103-53-07-01 Research on Self-Powered Metabolic Systems

Develop an ultra-light-weight, self-powered, miniaturized and personalized metabolic system to analyze and control the goes which man working in aerospace environments requires to mater his intake and measure quantitatively his inspired and expired respiratory gases as well as indicate volumetrically the supply of these gases. Study requirements for such a system will be accomplished prior to a contract for equipment. This will be coordinated with Eq. prior to release of contracts.

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10-77-770-100-53-07-02 Evaluation of Control-Display Parameters —Rdqt
Supplemental funding for BG-1893 to cover rising costs since initial approval of the program.

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01 EFFECTS OF THE SPACE ENVIRONMENT ON BEHAVIOR TASK AREA

21-87-870-100-52-01-01 Dehavioral Effects of Rotation and Acceleration —Amos
This task will include exploratory experiments on the effects of prolonged exposure to rotation and acceleration on behavioral functions of infra-human organisms.

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21-87-870-100-52-01-02 Heurcendreerinological Aspects of the Inter-relationships
Between Biological Rhythms and the Stresses of Space
Flight

Amos

(1) To establish normal patterns of rhythms such as body temperature, voluntary running activity, osmolarity of urine, and the estrous cycle in female rats and then subject these animals to physical stress (centrifugation, vibration, heat and cold, etc.). The effect of stress on the rhythms and the ability of the rhythms to adapt to chronic stress will be studied. (2) To investigate the

effect of disturbed rhythms on survival and health of such animals as rats and monkeys. This will consist of determinations of blood corticoids, blood glucose, eosinophiles, electrolytes, etc.

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02 NEUROLOGICAL & BIOCHEMICAL BASES OF BEHAVIOR TASK AREA

21-87-870-100-52-02-01 Physiology of Vestibular Nulceus

The vestibular nucleus has anatomical connections with structures concerned with varied actions both autonomic and voluntary. In the autonomic realm it has —bera to the nucleus of the vagus, the Edinger Westphal, the reticular substance, the archicerebellum, the limbic system, etc. Stimulation techniques will help to map out these connections and its actions. Information

obtained from these experiments is basic for the evaluation of the influence of motion-stress in space flights on the central nervous system, with particular reference to motion sickness.

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21-87-870-100-52-02-02 "End Points" in Neural Organization — Amos To provide new and improved models of neural mechanisms controlling posture and locomotion necessary for the design of meaningful physiological experiments.

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21-87-870-100-52-02-03 Vostibular Brain Machanisms

To analyze the CNS pathways which project upon the vestibular system and other anatomical substrata of functionally related brain mechanisms.

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21-87-870-100-52-02-04 Biochemical-Electrical Interrelationships in Simple Biological Information Storage Systems —Ames

Methods will be devised to implant microalectrodes into planaria ganglia, either in vivo or in vitro. The effects of stimulation of a variety of types on the ability of these structures to incorporate and metabolize radioactive precursors of the nucleic acids and proteins will be determined. In addition,

the effects of stimulation on utilization of energy rich compounds will be determined. (Ultimately, the enzymatic systems involved will be isolated and characterized).

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03 BIOLOGICAL INFORMATION, CONTROL & COMMUNICATION

SYSTEMS TASK AREA

10-87-370-100-52-03-03 Support of A Computer Technology Center for Research on kiNC Computers —Hdqt
To do research and development on MNC computers.

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04 EXPERIMENTAL ANALYSIS OF BEHAVIOR TASK AREA

21-87-870-100-52-04-01 Learning and Discrimination of Probability Schedule

To investigate the capabilities of subhuman animals in functioning as statistical analyzers when confronted with a choice situation where one of a number of alternatives may be correct. Which alternative is correct varies from trial to trial according to predetermined probability schedules. The demand on the organism in estimating which of the alternatives will be correct is twofold. He must combine the information received in the outcomes of

his previous trials in such a manner as to arrive at a useful average value for each alternative. Secondly, on any one trial he must make a decision based on these average values derived from previous experience. In performing this task, the animal is thus being asked to act as a computer, i.e., to integrate over previous outcomes. This type of behavior represents a direct and empirical attempt to obtain insight into how cybernetics principles can be applied to the study of behavior, and the close resemblance it bears to actual in-flight performance demands on human operators. In arriving at this average value the

operator must function as a probability statistic, the same as the animal is asked to do in the experimental situation. It will be important to first of all establish the techniques and methodology for presenting this problem so that the underlying variables can be analyzed quantitatively and varied in as controlled a way as possible. Once this capability has been achieved it will be possible to investigate some aspects of this process which have until now gone untouched.

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21-87-970-100-52-04-02 Environmental Determinants of Behavior

The purpose of this research will be to investigate the effects of temporature and humidity as paramentric determinants of behavioral functions. The discriminating and reinforcing functions of temperature and humidity will be explored. In addition the optimal temperature/humidity ranges for various behavioral functions will be determined.

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10-87-870-100-52-04-03 Circadian Rhythms in Man Undar Controlled Environmental Conditions

The investigation in man of circadian rhythms and zeit-

gaber stimulation.

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21-87-870-100-52-04-03 Control of Complex Behavior in Infra-Ruman Organisms

To extend experimental control over a total primate behavioral repertory. The task involves providing all requirements for maintenance of stable behavior in one or two subjects confined in a small chamber for periods of one year or more.

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21-87-870-100-52-04-05 Development of an Empirical Calculus of Reinforcement

The aim of this research program will be to develop techniques and procedures to calibrate reinforces. Schedules of reinforcement, amount, and duration of reinforcement, as well as the nature of the reinforcer itself, will be manipulated. A study will be made of the way in which these vari-

ables effect a quantitative index of relative reinforcement value previously developed by the principal investigated. Parametric studies of selected experimental variables will be made.

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54 Environmental Biology Sub-program

01 DEVELOPMENT OF EXPERIMENTS FOR STUDIES OF SPACE FLIGHT

ENVIRONMENTAL EFFECTS ON ORGANISMS TASK AREA

10-87-870-100-54-01-03 Study on Effect of Weightlessnass on Photosynthes

To determine the effect of weightlessness on photosy thesis of Chlorella algae. This is related to use of a photosynthetic gas exchange system in space travel and stations.

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10-87-870-100-54-01-04 Program of Research in Space Genetics

_Hd To determine the effects of space radiation on mutation of Neurospora fungi. Flight experiments will better define the biological effects space radiation.

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33-87-870-100-54-01-04 Tissue Equivalent Bosimater Feasibility Study

To develop a lightweight, reliable dosimeter for use of space probes to study the radiation hazard to manned space flight. At presen it is felt that a possible system would use a plastic scintillator with suitab output circuitry. Other systems will be studied.

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87 BIOSCIENCE PROGRAM 870 Director of Bioscience Programs 54 Environmental Biology Sub-program

To study the feasibility of recording the intensity of fungal luminescence as a reliable index in space biological studies.

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21-87-870-100-54-01-05 Instrumentation of Small Animais for Radiation Detection —Amos

To develop new techniques whereby animals can be instrumented for the detection of administered isotopes.

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10-87-870-100-54-01-08 Growth Patterns of Plants in the Absence of Eravity Effects —Hdqt

To determine the effects of zero gravity on the growth patterns and movements of plants. This will develop into flight experiments of effects of 0 g on plant morphogenesis.

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10-87-870-100-54-01-07 Life Sciences Instrumentation —Hdqt
Research into effective measurement, systems and system concepts for immediate application in circadian rhythm studies with small mammals and Drosophila and for future application as needed.

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10-87-870-100-54-01-08 A Workship on Biotelemetry

To support a workshop on biotelemetry so that biological scientists can be given better insight into uses of this type of instrumentation.

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02 GROUND STUDIES OF SPACE FLIGHT ENVIRONMENTAL EFFECTS

ON ORGANISMS TASK AREA

21-87-870-100-54-02-01 Effects of Low Magnetic Fields on Living Material —Ames
To study the effects of controlled magnetic fields lower
than the earth's magnetic field on: (a) survival; (b) growth; and (c) metabolism.
The ultimate objective is to have no magnetic field. A laboratory space will have
the earth's magnetic field shielded out by self-regulating Helmholtz coils, so that
magnetic fields down to 10-4 to 10-5 gauss will be available. Special non-magnetic
microscopes and instruments will be used so as to introduce no extraneous

magnetic fields into this environment. Long and short-term measurements will be made. Plant material will be used (such as the fungus Phycomyces), microorganisms such as the amos and other protozoa, and developing embryonic material such as the sea urchin and egg. Higher animals such as the mouse will also be studied in such an environment for physiological effects or changes in rhythmicity.

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10-87-870-100-54-02-02 Effects of Very Strong Magnetic Fields and of Magnet Field-free Environments on Animals and Man —Rdqt
To study the effects of high and low magnetic fields on

animals and human beings.

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21-87-870-100-54-02-02 Amelioration of Radiation Effects by Dietary Control-Ames

Exposure to sub-lethal doses of ionizing radiation result in changes in excitability of the Central Nervous System. Earlier studies have shown that single exposures to 250 or 500 result in a decreased threshold for electrically induced convulsions. Pre-feeding diets high in carbohydrate aggravated the symptoms; pre-feeding a diet high in protein tended to reduce the distortions.

Contractor shall conduct tests with a view towards determining the relationships between nutritional status, age, sex, and chronic and acute exposures to sub-lethal doses of ionizing radiation.

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21.87.870-100-54-CI-03 Effect of High Magnetic Field on Living Material — Ames To study the effects of controlled magnetic fields (normal to 30,000 gauss) m; (a) survival; (b) growth; and (c) metabolism. The emphasis is on controlled conditions and analysis of response. Developing embryonic material will be stressed. Imbination of factors (gravity, light, radiation, etc.) will be used. The sea urchin egg and the fungus Phycomyces will be used primarily. Both short and long-term consures will be made in a carefully-controlled environment. The temperature between the poles of the magnet will be carefully controlled as will

the light source. Special (non-magnetic) microscopes are being constructed for use between the rules of the magnet, so that the material may be observed while in the magnetic fund.

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21-87-870-100-54-02-05 Rediation Protection by Alteration of 6-1 Function —Ames Broakdown in cell permeability, massive hemorrhaging, and invasion of the body by intestinal bacteria is an earlier sequel to radiation exposure. Studies with animals have shown that increasing the mass of intestinal mucosa by pre-feeding a diet high in bulk (roughage or inert clay) protects against the "intestinal phase" of radiation deaths and increases the tolerance to lethal exposures by a factor of 15 percent. Further studies are required to evaluate more fully the protective changes associated with proliferation of the intestinal

mucosa. Contractor shall conduct studies with a view towards determining the relationship between gastro-intestinal function and radiation effects. Studies shall include tests of digestion and absorption of foods and the secretory function of the digestive tract all in relationship to radiation protection.

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21-87-870-103-54-02-36 Study Long-term Effects of Low G-loading on Plants—Amos
To study the effects of 1-10 G's in a specially constructed
centrifuge on (a) viability, (b) gross morphology, (c) reproducibility, (d) metabolism,
and (e) growth. The fungus Phycomyces will be used because of its demonstrated
gravity sensitivity. It has also been demonstrated to have a great sensitivity to
light and radiation so that it will be used in studying combination effects. Generations of Phycomyces and other plants will be raided in the centrifuge to study
adaptations to this environment.

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10-87-870-100-54-02-07 Research on Pathogen Free Plants in a Microcosm & on the Effect of High Intensity Light on Plant Growth —Hdqt

To study the effects of high light intensity on photosynthesis and methods for decontamination and growth of pathogen free plants. This work is related to gas exchangers and food supply systems in space travel.

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21-87-870-100-54-02-08 Study Long-term Effects of Low G-loading on Singleelical Systems — Ames

To study the effects of 1-10 G's in a specially constructed centrifuge on: (a) viability, (b) gross morphology, (c) reproducibility, (d) metabolism, and (e) rhymicity. Effects of combinations of such things as light, temperature, atmospheric pressure, etc. will be studied in combination with G-loading. Develop-

ing embryonic systems such as the froz egg and sea urchin egg will be used, as well as protozoa such as amoeba and paramecium. Organisms with known gravitational response (frog egg) will be stressed.

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Study of the direct effects of Irradiation with Alpha particles from the 60 inch Berkeley cyclotron on the metabolism of the brain.

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10-87-870-100-54-02-10 Individualized, Chemically-Defined Diets in Life Support Systems During Space Flight —Hdqt

The objectives of this research is to study dietary requirements of man and using man as a test animal, employing water-soluble, chemically-defined diets.

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21-87-870-100-54-02-10 Biological Effects of Ground Based Ionizing Radiation Ct-rays) Radiation ---Ames

Search for new methods for detection of radiation injury at the histochemical level. Before the damage can be detected by morphological alterations of the tissue elements.

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87 BIOSCIENCE PROGRAM
870 Director of Bioscience Programs
54 Environmental Biology Sub-program

02 GROUND STUDIES OF SPACE FLIGHT ENVIRONMENTAL EFFECTS

10-87-870-100-54-02-11 To investigate the Use of Perognathus as An Experimental Organism for Space Blolegy Research —Hdgt

To study the possibilities of using perognathus as an animal for research in space biology. The pocket mouse has been used as an indicator of the biological fate of radio active residues in areas adjacent to the Nevada test site and additional studies have endorsed the initial use of the pocket mouse for biological research in space.

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21-67-870-109-54-02-11 Effects of Simulated Extraterrestrial Conditions on Sometic Mitosis and/or Liutation Rate ——Amos

To develop basis for prediction of effects of extraterrestrial conditions on somatic mitosis and/or mutation rate, using morphologic and quantitative chemical observations on the genetic material of avian and mammalion cells, from experimentally prepared animals.

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10-37-870-100-54-02-12 Freezing and Drying of Living Cells —Hidgt investigation of hypothermia for an understanding of the mechanism by which it injures living cells.

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21-87-870-100-54-02-12 Effect of Space Voyage Stress on Synthatic Metabolic Processes

The purpose of this task is to determine whether the stresses imposed by space voyages (G-forces, weightlessness, vibration) on experimental animals (rats, rabbits, monkeys, dogs) have an effect upon the synthetic metabolic activity of isolated organs and tissues. Tissues such as a liver will be removed from strept d animals so that their metabolic activity can be assessed by in vitro techniques.

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10-87-870-100-54-02-13 Interdisciplinary Studies of the Effects of Space Environments on Diological Systems —Hdqt

To conduct research into effects of altitude, rare gases.

To conduct research into effects of altitude, rare gases, exirridiation and assimilated space conditions on biological systems.

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21-87-870-100-54-02-13 Nucleatide variations of certain tissues in Response to Some Environmental Alterations ——Amos To assay for acid soluble nucleotides (high energy com-

To assay for acid soluble nucleotides (high energy compounds) in selected tissues of the animal body and thus determine the level and distribution of the high energy phosphate compounds adenosine mono-, di-, and tri-, phosphates which are intimately concerned with energy metabolism. After baselines have been established, dynamic changes in these compounds will be followed during different environmental alterations.

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10-87-870-100-54-02-14 Biological Effect of Chronic Exposure to Artificial Atmospheres —Hidqi

investigation of the effects of prolonged exposure of small mammals to closed gaseous environments low in nitrogen.

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21-87-870-100-54-02-14 Protein Synthesis of Different Tissues of the Rat I Response to Various Corticolds

To see if tissues of the body demonstrate a polyphasi response to adreno-corticoids as has been shown for liver when protein synthesi is used as the means of evaluation. As a consequence the stress situation can better defined with respect to this parameter.

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10-87-870-160-54-02-15 Development of a Superior Diet for Man la Space -Hdi

The objective of this contract is to experiment will chemically-defined diets which include essential and non-essential L Amino acid and various other necessary components (in vitamins, minerals, carbohydrate fats, etc.). These diets will be developed in conjunction with the City of Hol Medical Center, Duarte, California.

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21-87-870-100-54-02-15 Reentgenographic Estimation of Bone Age in the Cynomolgus Monkey ——Amos

To determine by x-ray plates, the time of appearance of ossification centers and time of closure of epiphyseal plates in cynomologus monkeys of known age. The analysis of this data will subsequently be used to estimate ages of captured monkeys to be subsequently used in space biological research programs.

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21-87-870-100-54-02-18 Effects of Simulated Extraterrestial Conditions on Immune Mechanisms ——Ames

To determine effects of high energy irradiation, cold and hypoxia on the two major modalities of acquired immune response.

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21-87-870-103-54-02-17 Enclosure Monitoring of Fibrinolysis -

To determine the mechanism of activation of plasminogen (thereby leading to fibrinolysis and hemorrhagic tendancies) in blood during the physiological and psychological stresses encountered in the course of space exploration; with particular reference to possible control by the endocrine systems and nervous systems.

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03 BIOLOGICAL ANALYSIS OF TERRESTRIAL ENVIRONMENTAL

EXTREMES TASK AREA

10-87-870-100-54-03-01 Support of White Hountzin Alpine Research Station & Study of the Physiology of Natural High Altitude Hibernating Animals —Hide

Detailed physiological studies of the basic mechanisms involved in inducing, maintaining, and terminating hibernation in high altitude natural hibernators. Study of animals and human respiratory, cardiovascular, and paycho-physiological studies in relation to effects of high altitude, high ultraviolet and radiation and other environmental factors. Studies on photosynthesis and other processes in alpine plants in relation to studies with planetary simulation.

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04 EFFECTS OF SIMULATED EXTRATERRESTRIAL ENVIRONMENTS ON

EARTH ORGANISMS TASK AREA

21-87-870-100-54-04-02 Effects of Simulated Planetary Environment on Earth Organisms — Ames

To stimulate as accurately as possible the environments of planets of interest (Mars and Venus), and to study the effects of such environments on: (a) survivat, (b) adaptation, (c) metabolism, and (d) growth. Microorganisms (bacteria, fungi, lichens, algae) from extreme environmental conditions (desert, mountain tops, high salinity waters, polar caps, etc.) on earth will be studied. These will be introduced into a chamber and maintained as such environ-

mental extremes as will be encountered on Mars, for example (-100° C to $+30^{\circ}$ C; 0.1 atmosphere, no oxygen, high U.V., less than 1% $\rm H_2O$, etc.). Adaptation of organisms to such environments should yield information as to what types of organisms and metabolic pathways may be sought on extraterrestrial bodies.

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10-87-876-100-54-04-03 Biochemical Activities of Terrestrial Microorganisms in Simulated Planetary Environments —Hdqt

To study the growth and biochemical activities of terrestrial microorganisms under some of the conditions imposed by primitive and contemporary environments of the terrestrial planets.

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10-87-870-100-54-04-04 Research on Life in Extraterrestrial Environments — Hide To determine the types of earth organisms which ca grow and reproduce in simulated Martian environmental conditions.

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87 BIOSCIENCE PROGRAM 870 Director of Bioscience Programs 54 Environmental Biology Sub-program

04 EFFECTS OF SIMULATED EXTRATERRESTRIAL ENVIRONMENTS ON

10-87-870-100-54-04-05 Effects of Very Strong Magnetic Fields and of Magnet Field-free Environments on Animals and Man To study the effects of high and low magnetic fields on

animals and human beings.

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03 STUDIES OF BIOLOGICAL MATERIALS & SYSTEMS FOR USE IN

SPACE TASK AREA

10-87-870-100-54-05-01 Physiological Effects of Weightlessness and Space Radiations on Hibernators

To determine the effect of space radiation and zero G on hibernating animals. This work may lead ultimately to induced use of hibernation of astronauts for protection against radiation.

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21-87-870-100-54-05-08 Incorporation and Metabolism of Ritrogen by Plants

A study of the processes and pathways of nitrogen incorporation, fixation, and metabolism by plants will be the fundamental objectives of this study. The incorporation and metabolism of inorganic and organic nitrogeneus compounds by plants are influenced by the amount and form in which they are available. The principles of growth and development due to nitrogen will

be investigated. Conservation, utilization and recycling of human metabolic products in a closed environment, as in the ecosystem of orbital station or manned bases, relate to this field of study.

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10-87-870-100-54-05-07 Plant Leaves for the Production of Oxygen in a Closed System

To determine the potentiality of using vascular plants instead of aquatic algae for oxygen production and carbon dioxide utilization for a gas exchanger, and also for food production.

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Comparative Effects of Protons and X-rays on Intestinal Injury and Recovery in the Rat, Dog, Guinea Pig, and Hi-21-87-870-100-54-05-07 bernating Mammals

To compare the effects of protons and X-rays on Intestinal injury and recovery in the rat, dog, guinea plg, and hibernating mammals.

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Support of White Mountain Alpine Research Station & Study of the Physiology of Natural High Altitude Hiber-10-87-870-100-54-05-08 nating Animals

Detailed physiological studies of the basic mechanisms involved in inducing, maintaining, and terminating hibernation in high altitude natural hibernators. Study of animals and human respiratory, cardiovascular, and

psycho-physiological studies in relation to effects of high altitude, high ultraviolet and radiation and other environmental factors. Studies on photosynthesis and other processes in alpine plants in relation to studies with planetary simulation.

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10-87-870-100-54-05-11 Utilization of Bio-electric Potentials -Hdat To demonstrate the feasibility of utilizing bioelectrical potentials as a primary power source for implanted electronic devices.

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55 Exobiology Sub-program

OI EVOLUTIONARY & THEORETICAL BIOLOGY TASK AREA

10-87-870-100-55-01-01 Studies of Extremely small self-replicating Systems-Hdgt To obtain detailed knowledge of cell systems at the extreme limit of small size, i.e., 0.2 microns (1/5 the size of average microorganisms). The observations made will be helpful in determining criteria for what constitutes a living system.

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10-87-870-100-55-01-03 Studies on the Hill Reaction Activity of Soluble Chloroplast Extracts — Hdqt

To characterize photo-chemically active extracts of chloroplast, to define the components required in the photoactive system and to learn the role of each in the energy transfer process.

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10-87-870-100-55-01-04 Molecular Evolution

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To produce for the first time "protobiological" systems or precellular chemical systems incapable of reproduction but which may carry out relatively complex metabolic reactions. Materials containing iron or zinc will be introduced into Miller type mixtures in order to make the above required metalloorganic catalysts a possibility.

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21-87-870-100-55-01-04 Synthesis of Protein Microspheres to Serve as A Cell Model for Research on the Origin of Life, etc. —Ames

Synthesis of high molecular weight polypeptide molecules, which on proper treatment gives rise to formed spheres which have many of the properties of cells. Attempt to improve the composition of these microspheres by incorporation of lipid, poly-saecaride and other complex molecules) in order to make them more and more cell-like, with the ultimate aim of constructing a self-replicating functional unit. Study of primitive earth and extraterrestrial en-

vironmental variables (such as gaseous composition and pressure, moisture content, temperature, chemical composition, radiation, etc.) on such synthesis. The use of such cells or cell models to study bioorganic evolution and the origin of life on earth and elsewhere in the universe.

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18-07-879-169-55-01-08 Microspectrophotomatry of Pigments & Organic molecules —Hdqt

To develop and utilize microspectrophotometric instrumentation for the study of pigments and organic molecules within living cells.

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21.87-870-100-55-01-08 Chemistry of Formation of Biologically-significant Molecules Under Primitive Earth and Extraterrestrial Conditions

To study the synthesis of biologically-significant molecules under conditions which may have prevailed on the primitive earth or some other planet. To determine possible pathways of chemical evolution along which life could have arisen.

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21-87-870-103-55-01-07 Properties of Monolayers of Ceil Membrane Components at Liquid Interfaces —Ames

To increase the understanding of the type of interaction between various organic compounds, known to be part of cell membranes, within a monolayer and their interaction with the adjacent liquid phases.

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21-87-870-100-55-01-08 Physico-Chemical Properties of Artificial Multilayer Systems

This study is aimed at the problem of transformation of radiant energy into chemical or electrical energy as exemplified, for example, by the lamellated structure of the chloroplast.

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10-87-870-100-55-01-10 Dynamic Systems Response of the Performance Characteristics of Some Major Biophysical Systems of Interest

—Hdci

Study of the physical modeling analysis of the mather matical physical dynamics of major internal human systems. This proposal is directed at four such systems: the thermoregulation system control, the cardia vascular system control, the hormonal signaling system control, the behavioral system response control.

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87 BIOSCIENCE PROGRAM 870 Director of Bioscience Programs 55 Exobiology Sub-program

OI EVOLUTIONARY & THEORETICAL BIOLOGY TASK AREA

21-87-870-100-55-01-10 Effects of Extraterrestrial Conditions on the Metabolism of Tissue Maintained in Culture —Ames

Methods will be developed to maintain human and animal brain tissue in long-term cultures in vitro and these cultures will be used to assess the effects of conditions which exist in space on their metabolism. Radioactively labeled precursors of the nucleic acids and proteins of the tissues will be in-

cubated over prolonged periods and such factors as high magnetic fields, electrostatic fields, gravitational force and the like will be altered. The effects of these forces in combination with various drugs will also be examined.

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10-87-870-103-55-01-11 Molecular Energetics
To study califemetry of enzyme-coenzyme substrate in-

To study califemetry of enzyme-coentyme substrate interactions and dehydrogenese systems and califemetry of primary steps in photo synthetic carbon dioxide assimilation.

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21-87-870-100-55-01-11 Factors Controlling the Formation of Hereditary Materials

These studies are forerunners to studies of life forms on extraterrestrial bodies in order to understand some of the basic mechanisms involved in the transmittal of hereditary traits from parent to progeny.

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10-87-870-100-55-01-13 Organic Cosmochemistry —Hdqt

To synthesize purines and pyrimidines under possible primitive earth conditions. This is a part of NASA's overall program in evolutionary and theoretical biology aimed at the recapitulation of major chemical events in the origin of life.

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21-87-870-189-55-01-13 A Study of Molecular Structures and Reactions Occurring in Biological Systems Irradiated with Ultraviolet Light
—Ames

The mechanism of action of ultraviolet light (UV) on living systems is of special interest in those environments, such as on Mars, where the UV flux is probably quite high, of special interest are those biological systems which can partially reverse these effects. It is proposed that these be studied.

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10-87-870-100-55-01-14 Space Bioscience Institute

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To conduct experiments on the origin of life, molecular evolution, models of Mars and Venus, prepare for analysis of returned samples, develop concepts for detection of life, participate in biological satellite experiments

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21-87-870-100-55-01-14 Study of Smallest Replicating Units of Heredity

To determine the chemical character of, the physical structure of, the mode of replication of, and the mechanism of action of bacterial episomes, the smallest known independently replicating genetic units.

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10-87-070-100-55-01-15 Primeval Synthesis of Perphine-like Substances —Hdqt
To synthesize under primitive earth conditions perphine-like substances. Pyrrole and aldehydes will be used as beginning materials and ultra-violet and electrical discharges as a source of energy.

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21-87-870-100-55-01-15 The Mechanism of Radiation-Induced Delay of Cell Division

These studies are important preliminaries to studying the effects of the radiations of outer space on cell division. Call division is absolutely required for the proper function of such vital organs as bone marrow, intestinal epitholium and skin, and the action of space radiation on cell division must be better understood before long-range space trips can be undertaken by man.

lactic, malic, glutamic, as well as other pyrimidine nucleotide linked deh x genases and DNA from the most primitive to the most advanced organisms.			leamy.	<u> </u>	oth form 1st 7 62
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hotosynthatic Organisms — Ames Convoctor BRANDETS UNIV _ of work MADD					21-87-870-100-55-01-16 R
ects of intense visible light, and so of cellular components by photo-ed to ionizing radiation if possible, all and extraterrestrial) suitable for	ts by photo- if possible.	ular componentizing radiation	and loss of cell extended to lo	photosynthesis ar In studies to be a	ultraviolet light on the ph synthetic organisms. Such
nisms of origin of photosynthetic					
10-87-870-103-55-01-20 Physics of Cellular Synthesis, Growth and Division — To characterize a theoretical basis for the discreti			12 . V 1	76	·
the processes of synthesis growth and differentiation of a living cell. Research be done into the effect of heat on bacterial kinetics, e.g., the effect of gr	House Contr	1 10	2 Compl	7 6	Dates feme 7162
^ F coli at temperatures from 2 to 48 degrees C, on the division rate, upto		'		- P	rech. Rep. ZILL L
proline, alanine, glucose, uracil, T-32 and S-35, formation of betagalactosidais uptake of thymine (for E. Coli 15 T-). Rates of synthesis and pool sizes w	i,	1. Tot	Prof	FY 43 Man Yrs	Task Status NEW
measured. Special attention will be given to the measurement of action energies in these processes and relation to reaction kinetics will be structures (1) to isolate and of organelles which carry on the themical and physical properties of the structures (lamellar) observed determine the enzymic mechanisms eactions of these lipids and their inthesis process; (4) to study the	isolate and arry on the roperties of ar) observed mechanisms s and their	m is: (1) to elles which cand physical partures (lamelle the enzymic of these lipid	of this progra ments of orga the chemical ment in the str (3) to determinations	The objective of the lipid composite (2) to determine for their involvem fon microscopy; (bolic and catabo	themically characterize the photosynthesis process; (2 these lipids as a basis for in chloroplastic by electro responsible for the anab
poproteins or proteolipids and their lastellenen LACORS C	ds and their	or proteolipi	s as lipoproteir	ds with proteins	conjugation of these lipid
terrestrial situations.	the role of	To determine	he chloroplast.	d function of th	role in the structure and photosynthesis in extrate
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			Prof	FY 63 Man Yrs	Tesk Sterus NEW
02 INSTRUMENTATION FOR DETECTION OF EXTRATERRESTRIAL LIFE 1	1,	l, Tet		1	
2 INSTRUMENTATION FOR DETECTION OF EXTRATERRESTRIAL LIFE 2 LIFE-RELATED COMPOUNDS TASK AREA 10-87-870-100-55-02-01 Cytochemical Studies of Planetary Microorganisms of reflection spectra as a basis for chemical laboratory ("multivator") for the detection and study of extrater is structure and to study Pre-Cambrian rocks with perrestrial, biological residues and to ergy, followed by identification of structure and the restriction of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the	hemical Evo- —Hdqt a basis for tructure and rocks with idues and to attification of	Analysis and C ion spectra as termine the s r Pre-Cambrial biological res lowed by ide	ature of reflectial life. To describes, to studies of terrestrial UV energy, fo	Reflection Spect lution To study the na on extraterrestric out of the fate life and the fate friments using t	interpretation of data or amount of carbon compo respect to the origin of i repeat Miller type exper
2 INSTRUMENTATION FOR DETECTION OF EXTRATERRESTRIAL LIFE 2 LIFE-RELATED COMPOUNDS TASK AREA 10-87-870-100-55-02-01 Cytochemical Studies of Planetary Microorganisms To conduct research, design, and test a miniature of reflection spectra as a basis for chemical laboratory ("multivator") for the detection and study of extrater life. Also, to study the feasibility of a vidicon microscope for the examinate particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or ba	hemical Evo- —Hdqt a basis for tructure and rocks with idues and to stification of spectrometry. EFFORT	Analysis and Committee the section of the section o	nature of reflectial life. To describes, to studie of terrestrial UV energy, for chromatograp	Reflection Spect lution To study the name extraterrestring ounds in meteo life and the fate riments using to means of paper	interpretation of data or amount of carbon comporespect to the origin of li repeat Miller type exper resultant compounds by i
2 INSTRUMENTATION FOR DETECTION OF EXTRATERRESTRIAL LIFE 2 LIFE-RELATED COMPOUNDS TASK AREA 10-87-870-100-55-02-01 Cytochemical Studies of Planetary Microorganisms To conduct research, design, and test a miniatu chemical laboratory ("multivator") for the detection and study of extrater life. Also, to study the feasibility of a vidicon microscope for the examinate particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the field by spectrophotometry. Task EFFORT Interest Issue 1 1 6 2 Complete Interest Interest Issue I I 6 2 Complete Interest Interest Issue I I 6 2 Complete Interest Interest Issue I I 6 2 Complete Issue I I 6 2 Comple	hemical Eve- Heqt a basis for tructure and rocks with idues and to stification of spectrometry. EFFORT House Contr	Analysis and Committee the section of the section o	nature of reflectial life. To describes, to studie of terrestrial UV energy, for chromatograp	Reflection Spect lution To study the name extraterrestricularies in meteolife and the fate riments using I means of paper	interpretation of data or amount of carbon comporespect to the origin of li- repeat Miller type exper resultant compounds by a Tesk Form lat poles lesse 1 1 6 2
2 INSTRUMENTATION FOR DETECTION OF EXTRATERRESTRIAL LIFE 2 LIFE-RELATED COMPOUNDS TASK AREA 10-87-870-100-55-02-01 Cytochemical Studies of Planetary Microorganisms of reflection spectra as a basis for to determine the structure and to study Pre-Cambrian rocks with the prestrial, biological residues and to ergy, followed by identification of matography and mass spectrometry. Task Form 1st Detection of Life Also, to study the feasibility of a vidicon microscope for the examinal particles or bacteria morphologically with follow-up observations of the particles of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles of particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the particles or bacteria morphologically with follow-up observations of the pa	hemical Evo—Hdqt a basis for tructure and rocks with idues and to stification of spectrometry. EFFORT House Contr	Analysis and Comments the service the service the service the service the service that the	nature of reflectial life. To descrites, to studie of terrestrial UV energy, for chromatographic 2 Est Tosk	Reflection Spect lution To study the name extraterrestricularies in meteolife and the fate riments using I means of paper	interpretation of data or amount of carbon comporespect to the origin of lifepeat Miller type exper resultant compounds by a Tesk Form lat poles lesue 1 1 6 2 Installation QUIMBY

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87 BIOSCIENCE PROGRAM 870 Director of Bioscience Programs 55 Exobiology Sub-program

02 INSTRUMENTATION FOR DETECTION OF EXTRATERRESTRIAL LIFE &

LIFE-RELATED COMPOUNDS TASK AREA

33-87-870-103-55-02-02 Enzymatic and Fluorometric Techniques — JPL

To establish complete fluormetric analytical procedures for the determination of the nature and concentration of a wide range of biologically important compounds for later Mariner 3 missions.

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10-87-870-103-55-02-03 Radiosotopic Probe for Extraterrestrial Life — Hdqt To design, develop, test and produce a prototype device for the detection of extraterrestrial life by means of the metabolic production of labelled ${\rm CO}_2$.

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33-87-870-100-55-02-03 Desert Microflora

To determine the interrelationships between the soil environment and its indigenous microflora in preparation for the instrumentation and design of extraterrestrial life detection experiments. To develop, by 1955, a soil probe capable of measuring the chemical and biological properties of planetary soils including soil water, gases, temperatures, microbial abundance and other relevant biological parameters of the soil environment.

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10-87-870-100-55-02-04 A Microscopic system for biological research — Hdqt
Research into design of a microscopic system for biological work employing automatic photoelectric registration of dichroism, optical rotation, and phase retardiation due to refraction and birefringence.

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21-27-870-100-55-02-05 Life Detection in Planetary Models and Simulators --- Ames

To use planetary models and simulators to estimate those physical conditions which have biological significance on planets. To determine the effects of these conditions on living systems and improve our capabilities for life detection under these conditions.

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33-87-870-100-55-02-05 Blology - Gas Chromatograph

To study design, develop and test functional model of a gas chromatograph that will perform organic analysis of a solid Martian sample for the specified purpose of biological detection.

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10-87-870-103-55-02-03 Detection of Extraterrestrial Life by Optical Rotation—Hidge To determine the feasibility of detecting extraterrestrial life by means of rotary dispersion profile of pure DNA, including simple optical rotation in the 2600 Angstrom UV region.

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10-37-870-100-55-02-07 Octection of Extratorrestrial Life by UV Spectromatry

To develop a life detection concept based on the Identification of the classical peptide bond which exhibits an extremely high specific absorption in the far ultraviolet (1850 Angstroms).

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10-87-879-100-55-02-08 Indentification of Organic Matter by Mass Spectrometry Hdot

To determine the feasibility c. identifying life related compounds by means of their mass spectrum.

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Development of breadboard model of Mars biological microscope includes special studies of problems associated with development of instrument. a. lenses used; b. micro illumination; c. sample collecting and handling; d. biological staining; e. auto focus mechanism.

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33-87-070-103-55-02-63 Biology & Carbon 14 —JPL
To help coordinate efforts of Resources Research, Inc. to develop prototype and flight hardware of Radioisotopic Biochemical Probe for Extraterrestrial Life Detection.

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10-57-870-100-55-02-10 Detection of Extratorrestrial Life by "I" Dands — Hidat

To determine the feasibility of detecting protein by
means of "I" band formation—a color change produced by intense absorption of
light in the visible spectrum when certain dyes react with protein.

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33-87-270-100-55-02-10 Instrumentation for Datection of Extratorrestrial Life Related Compounds — JPL

Define methodology for performing several types of entyme analysis using fluorometric techniques in support of multivator experimenter.

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21-87-870-10G-55-02-12 Life Detection Devices

To conceive, develop, and test Life Detection Devices for use in the study of life on extraterrestrial bodies.

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\$3-87-870-100-55-02-23 Exoblology Instrumentation

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Dasign, development, fabrication, and testing of systems subsystems, and techniques which will permit detection of organic compounds or organisms found in a planetary atmosphere or on a planetary surface.

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33-67-870-160-55-02-33 Biology—Mars Microscope

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Design, development, fabrication, and testing of systems, subsystems, and techniques which will permit observation and analysis of organic compounds or organisms found in a planetary atmosphere or on a planetary surface.

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33-07-870-100-55-02-39 Exobiology Instrumentation

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Design, development, fabrication and testing of systems, subsystems, and techniques which will permit collection and analysis of organic compounds or organisms found in a planetary atmosphere or on a planetary surface.

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87 BIOSCIENCE PROGRAM 870 Director of Bioscience Programs 55 Exobiology Sub-program

03 SPECTROSCOPIC STUDIES OF PLANETARY ATMOSPHERES & SURFACES TASK AREA

10-87-870-109-55-03-01 IR Planetary Observations In the Etrafecipliers ——Ideqt Same as NsG-255-62 (joint project between California (Berkeley) and Princeton). With the exception of the FY 63 \$100,000 above, the Stratescope II telescope is being loaned to the IR observations with verbal assurance that costs of repair will be covered in the event of substantial damage during recovery.

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10-87-870-100-55-03-02 IR Planetary Observatory in the Stratosphere —-- Adqt

To obtain IR spectra of Mars and perhaps Venus (with
the moon as control) above the major portion of the earth's moisture-laden atmosphere, Princeton University, under another grant, will provide a 36" telescope, balloon, and operations.

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04 EXTRATERRESTRIAL SAMPLE COLLECTION & ANALYSIS TASK AREA

10-87-870-100-55-04-01 In-flight Photography and Recovery of Meteorites —Hdqt
To track and recover meteorites by means of camera
triangulation stations scattered over 1,000,000 square kilometers in the Midwestern U.S. including parts of Texas.

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21-87-970-100-55-04-01 Provide Laboratory and Suitable Technology for Detailed Analysis of Returned Extraterrestrial Samples —Ames

To establish a central laboratory with the required special equipment and techniques to acquire, return, and analyze completely, returned extraterrestrial samples, from both a biological and biochemical point of view. To develop special sampling and handling techniques and where necessary, analytical techniques.

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10-87-878-188-88-84-82 Sampling for Microbas in the Stratesphere —Hdgt
To determine the nature and distribution of microorganisms in the atmosphere up to 93,880 feet. Preliminary results indicate that pigmented forms exist in unexpectedly high numbers at 65,000 feet.

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10-37-870-100-55-04-03 Analysis for Hydrocarbons in Mineral Aggregates —Hdqt
To develop and apply techniques to the analysis of representative samples of hydrocarbons present in low concentrations in terrestrial mineral aggregates.

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Tesk Status	NEW	FY 63 Man Yes	Prof	.	Tot .	•

21-87-679-163-55-04-03 Analysis of Blo-organic Materials of Extratorrestrial Origin

The organic chemical analysis of meteoritic material to investigate the origin of formed "fossil-like" bodies found in such material. To study organic compounds in meteorites, as to the possibility of living origin, and to compare such material to natural and synthetic compounds on earth. Meteorites to be obtained from existing collections (Dr. Calvin, the Smithsonian Institute) and also from collections obtained from NASA contracts.

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Tesi Status	NEW	'		FY 43 Man Yes	Prof	1,	Tes	i,

10-87-279-103-55-04-04 Biogeochemical Studies of Mateorites —Hdqt
To determine the nature and origin of organic material
in meteorites.

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Tesk Status	NEW		FY	63 n Yss	Prol	• '	Tet	•

18-87-070-100-05-0-405 Development of Upper Atmosphere Sampler

To develop a means of sampling the microorganisms the upper terrestrial atmosphere. To accomplish maximum recovery from large samples of ambient air without the danger of significant contamination.

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Solve Status	N E W 103-55-04-07 of equivalent of eggs, inclu-	FY 63 Mem Yes Figure carbon And To conduct a s t compounds from ding an analysis of	urvey of var organisms their biogan	el work cotion of l rious natu and sedir	Tos Life ral lipid nents of	f different nstituents.
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on rector Total Status 10-27-270- (solution (genological Test Form 1s Detect is actel. Status	N E W 103-55-04-07 of equivalent ages, inclu-	FY 63 Mem Yes It directorbas And To conduct a st compounds from ding an analysis of 2 1 6 Y F H	ibits la Bot urvey of var organisms their biogar	ef work cotton of I rious natu and sedir nically proc	Tel	s and the f different nstituents.
on Proctor Forh Status 10-27-27-2- solution (genological Forth Form 1: Detect is natel.ctron sch. Rep. Lantroctor	NEW 103-55-04-07 of equivalent ages, including 1 1 1 1 6 QUIMB	FY 63 Mem Yes It directorbas And To conduct a st compounds from ding an analysis of 2 1 6 Y F H	theis in Bot urvey of var organisms their biogan chair took	ef work cotton of I rious natu and sedir nically proc	Tel	s and the f different nstituents.
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Contractor Took Status 10-27-27G- isolation (genologica Took Form 1 Detes Is action (genologica Took Status 10-87-870- meteorites stzining, Took Form 1 Detes Is Institution on Tech, Rep.	NEW 103-55-04-07 of equivalent ages, included ages	FY 63 Mem Yes It decearbes And To conduct a s t compounds from ding an analysis of P F H RESRCH FY 63 Wan Yes It was Y	cs identification spectrophot	of work cotion of livery nicely proc	Tes Life ral lipid ments of inced complete comp	s and the f different notituents. FFORT X
Tosk Status 10-27-373- isolation (genologica Tosk Form In Deta Is attaliation fach, Rep. Contractor Tosk Status	NEW 103-55-04-07 of equivalent ages, incluing the second of the second	FY 63 Mem Yrs It crees be a And To conduct a s to compounds from ding an analysis of the state	cs identification spectrophot	of work cotion of frous natural sedimically produced on organ omatric termicrospec	Tes Life ral lipid ments of inced complete comp	Hdgt pounds in biological metry.

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CS STERRIZATION OF SPACECRAFT TASK AREA

10-07-870-100-55-05-01	Sterilization of Space Probes	 ₩₫
	To develop standard operation procedu	ires for the appl
cation of heat to space missions destined for Ma	craft or to capsules in toto in order to (completely sterilize

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10-27-073-103-55-85-02 Sterilization of Spacecraft —Hdi Studies and development of methods for the decontamintion of spacecraft with emphasis on levels of natural contamination in component and the utilization of ethylene oxide for surface sterilization.

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10-87-370-160-55-05-CS Viability of Organisms in Simulated Space —Hd To determine the ability of microorganisms to survivarious combinations of freezing, ionizing radiation, dessication, UV, and spavacuum.

vacuum.				
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91 MANNED SPACECRAFT SYSTEMS PROGRAM 910 Director of Spacecraft & Flight Missions

49 Human Performance & Behavior Sub-program

OI PERCEPTION TASK AREA

10-91-910-101-49-01-67 Human Engineering Design Criteria for Space Systems Development of human engineering standards for use in

design and development of space vehicles and associated equipment.

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04 MAINTAINING ASTRONAUT ALERTNESS TASK AREA

10-91-910-101-40-64-09 Maintaining Astronaut Abertness ---Hdzt To define alertness operationally in terms of astronaut task requirements, to develop methods and criteria for its measurement, and to develop methods for its maintenance during the critical aspects of flight missions.

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51 Physical Biology Sub-program

03 CONTROLS & OPERATIONS TASK AREA

35-01-910-101-51-03-01 In-flight Simulation for Debavioral Studies

To develop equipment for controlled studies of astronaut · performance during flight. Equipment and test will be developed to permit studies of pilot performance in tasks not necessarily associated with direct control of the spacecraft.

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23-S1-S10-101-51-03-02 Crew Activities Associated with Space Flight Open.—INCO To provide, for the autronauts, an early familiarization with the various dynamic phases of a lunar mission and to investigate the feasibility of manual control in several critical phases of the lunar mission.

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TASK CROSS INDEX BY HEADQUARTERS PROGRAM OFFICE

			51 Physical Biologi	6. 1
770 DIRECTOR C	F BIOTECHNOLOGY AND HUMAN	ŧ		V 300-program Effects of Isolation, Sensory Deprivation & Sensory
RESEARCH	,, 5,0.20,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			Rearrangement —Hast
KEJEAKO				Skilled Performance in Space Vehicle Control —Acces
				Handbooks of Human Factors Mathods — With
49 Human Perform	ance & Behavior Sub-program			Communication in Space Operations —Amas
21-77-770-103-49-01-01	Reprohermental Studies as Related to Space Fligh		10-77-770-168-51-61-03	
21-77-770-103-49-01-02	Pituitary Chamistry	—Atus		Pilot's Ability to Cope with Sudden Changes in the Can-
10-77-770-183-49-61-63	Respiratory	Häut		trolled E cment — image
21-77-770-100-49-01-03	Research in Cerebral Neurophysiology and Its &			Characteristics of the Segments of the Ruman Body
	In Monitoring Behavioral States	<u>Anies</u>	21.77.773.170.51.01.04	Application of Reliability Theory to the Allocation of
10-77-770-100-49-01-05	Central Regues System	22st		Function Setween the Pilot and the Vehicle Systems—Amas
10-77-770-100-49-01-00	Central Norvous Systems	—Hdat	18-77-778-103-51-01-05	
16-77-770-100-49-01-07	Central Harvous System	—lidat		Problem Areas Associated with Flight Through Turbulant
10-77-776-100-49-81-63	Central Nervous System	—Hdst		Air —Amas
10-77-770-100-49-01-09	Eastrointestinal and Metabolic	—Hdat		Vestibuler Motion Cues Used by the Human Pilot -Amis
10-77-778-163-48-81-10	Endiorina	—X.Cat	21.77.770.100.51.01.07	Human Pilot Control Problems in a Manned Planalure
10-77-770-100-49-02-01	Ion Effects on Man	—Rdat	21-77-730-103-31-01-07	Landing — And a
21-77-770-100-49-02-01	Vision, Circulation and Respiration under Sus		21-77-778-188-51-61-88	Basign Principles for Display and Control Systems for
	estaration	Ames	2.77,770 100 01 01 00	Racovery from Unusual Attitudes —Attac
10-77-770-100-49-02-02		Kdat	21-77-770-100-51-01-09	Human Pilot Control Problems in a Manual Abort of a
21-77-770-100-49-02-02	Study of Long-Term Effects of Low G-loading of		2	Lunar or Planetary Mission —Amas
	(mice, rats, etc.)	—Ames	21-77-773-168-51-61-10	Effects of Individual Environmental Stresses of Space
10-77-770-100-49-02-03		222	2	Flight on Human Pilot Performance -Amas
21-77-770-180-49-62-03	Metabolism of Animals as Influenced by Space		21-77-776-100-51-01-11	Biological Control Systems—A Comprehensive and Critical
	mental Conditions			Review of the Field —Amos
10-77-770-100-49-02-04		—Hdat	21-77-770-100-51-01-12	Utilization of Bioelectric Potentials. Support Phase 1
	Radiation Dosimetry and Measurement	Ames	10-77-770-103-51-02-01	
10-77-770-100-49-02-05		Hdat		Operator Selection for Space Missions -Ames
21-77-770-100-49-82-65	Theoretical Study of High Energy Radiations i			One-Man Vehicular Locomotion —L.33
	to Biological Systems	Attes		Remate Control Systems —Rest
10-77-770-100-49-02-03	HECIGION	—Hjat	21 77 773 100 61 02 01	Development of Physiological Montioring Equipment for
	Effects of High G Loading on Metabolism	—Ames —Hdat	21-77-770-100-31-03-01	Use in Motion Flight Simulators and Aircraft —Aircr
10-77-770-160-49-62-07			24 77 772 100 51.02 01	Crew-Aircraft Integration —F32
21-77-770-100-49-02-07	Pathological Studies on the Brains of Mice	and the		Evaluation of Advanced Integrated Display & Conform
	Monkey to be Exposed to Cosmic Radiation in Hi		1977-770-150-31-03-32	Systems — 222
	Dalloon Flights	22MA	21.77.770.120.51-03.02	Piloted Simulator Requirements for Effective Resourch.
16-77-770-100-49-02-03		Kdat	21-77-770-103-37-03-02	Development, and Training —A.T.
	Space Physiology (Extension of HsG 139-61)	æam£—	10.77.770.180.51.00.03	Advanced Integrated Display & Control Systems — Dist
	Predominating Fecal Flora in Man			Determination of Pilot Dynamic Characteristics —LAC
21-/7-/70-100-49-02-03	Histoopathological Study of the Effect of Fig		2077 770 130 07 00	200
	ments on the Central Nervous System and Selec		53 Life Support S	ub-propram
11777777100 40 00 17	(MAS 2-1336)	—}es —‼⊴at		Photosynthetic Gas Exchanger - Halot
	Non-tonizing Energy Fields Persmetric Study of Flight-Induced Pulmonary			Heat Regulation at Reduced Pressures -Artes
	Hon-lonizing Energy Fields	-Hant	23-77-770-120-59-01-01	Development of Life Support Systems —LTD
21.77-770-180-48-82-11	Electroneurophysiological—Task Performance			Electrolyta Oxygen Concrator — Hide:
	Atmospheric Conditions	—Hást	21-77-778-103-53-01-02	Regenerative Characteristics of Adsorbers Used in En-
21.77.770.100.43.02-12	Biological Research with Reavy Ion Beams			vironmental Control Systems -Ames
	Atmospheric Conditions	—Hdet	23-77-779-189-53-81-02	Integrated Advanced Life Support SystemLGO
21-77-773-183-49-82-13	Desimetry of high Energy Radiation	Ātabs	10-77-770-160-53-01-03	Parameters Essential for Manned Flight Operation - Suct
	Atmospheric Conditions	Hdat	21-77-770-103-53-01-03	Closed Life Support System Optimization Studies Amics
21-77-772-100-49-02-14	Post-Aurtem Clinical Analysis of Biological		10-77-770-105-53-01-04	Integrated Human Maintenance Subsystem — II:
10-77-770-100-49-02-15		—Kdat	21-77-773-133-53-01-04	Effects of High Oxygen Tensions on Central Hervices
13-77-770-100-49-02-16		H∴at		System —Amas
13-77-770-100-49-02-17		Hdat		CO. Reduction System —Mdat
16-77-770-163-49-62-18		—Rdet		Use of Ozonides for Air Revitalization Hust
	Environmental Physiology	—Hdet	16-77-770-103-53-01-07	
13-77-770-100-40-02-20		Käst	10-77-773-103-53-63-01	
	Free Space-Extravehicular and Surface En	vic6amentai	21-77-778-163-53-03-01	Basign Construction and Test of an Integrated Namun
	Studies	—Hdat		Maintenance Subsystem —Ames
16-77-770-100-49-03-01	Pharmacology, Prophylaxis and Therapy	Hdat		Improvement of the Ames Support and Restraint System
21-77-770-100-49-03-01	Ocular Impedance Plethysmography	Ames		Anthropometric Devices for Planetary Exploration —Amaz
10-77-770-100-40-03-02	Toxicology	—Kšat	· ·	Miniaturized TV Camera — Hum
	Effect of Rough Air on Aircraft Crew Performs	ance —LRC	19-77-778-133-53-68-01	The state of the s
	Matural Rhythmic and Circadian Patterns	—#.Jut	21-77-776-163-53-08-61	· · · · · · · · · · · · · · · · · · ·
21-77-770-105-45-04-01	Auditory Perception During Space Mission	—Ames	24-11-113-153-55-65-61	Psychophysiological Information Acquisition Processes
23-77-776-160-48-64-61	Studies of Man in a Rotating Environment		40 77 770 400 50 60 00	and Control System (PIAPACS) —FILL
13-77-770-100-43-04-92	! Information Reception & Transmission	—‼d≤t		Photosynthetic Gas Exchanger — N.1.
#14-17-70-100-10-04-02	Visual Perception Bering Space Missions	—Amos	21-11-116-165-53-66-62	Study and Evaluation of Psychophysiological Monitoring
20-17-170-100-40-04-02	2 Determination of Visual Acuity	—LRC	ነር ግግ ማጀር ነላና ≛0 በተ ሰ ባ	Techniques for Use in Advanced Aerospace Missisha
14-77-773-100-10-01-03	Concern Mechanisms	—::::::tet		Human Factors Bioinstrumentation — Mich Biological Design Studies of Man — Area
41-11-110-120-46-04-03	Decision Making in Space System Operation	Aines		Biological Design Studies of Alan —Alacs Evaluation of Control Display Parameters — —Nica
77.77.79.103.48.04.04	Corebral Machanisms	Hilat		Research on Self-Powered Metabolic Systems —FA
23.77.770.103.40.05.0	1 Examination of Methods for Simulating Zero "	ERS —LRS		
4.4-4.1-1.111.15 7.50 55 95	2 Human Behavior and Performance Buring Sim	miated Lung	10-11-110-100-00-01-04	! Evaluation of Control-Display Parameters — Hdu:

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Duration Missions

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870 DIRECTOR OF BIOSCIENCE PROGRAMS	21-87-876-190-54-94-92	nating Animals Edat Effects of Simulated Planetary Environment on Earth
	10-87-870-100-54-04-03	Organisms —Ames Elephomical Activities of Terrestrial Microorganisms in
52 Behavioral Biology Sub-program		Simulated Planetary Environments —Hdat
21-57-576-763-52-61-61 Echevicital Effects of Rotation and Acceleration —Atmas	10-87-870-180-54-04-04	Research on Life in Extraterrectrici Environments —Haat
21-57-570-160-52-01-02 Reuroendrearinglagical Aspects of the Inter-relationships	10-37-873-100-64-04-05	Effects of Very Strong Megnetic Fields and of Meanot Field-free Environments on Animals and Man —Hact
Detween Diological Rhythms and the Strasses of Succe	19.87.879.100.52.05.81	Physiological Effects of Violentlessness and Space Radi-
Fight —Amos		alions on Hibernators —Hdot
21-87-870-100-82-82-01 Physiology of Vestibular Kulcous —Ames 21-87-870-100-82-82-82 "End Points" in Nourcl Organization —Ames	21-87-870-100-54-05-00	Incorporation and Metabolism of Ritrogen by Plants
21-67-870-160-62-90-93 Vestituter Broin Mechanisms ——Ames	19-87-879-100-54-65-97	
*21-07-870-100-52-02-04 Bischemical-Eisetrical Interrelationships in Simple Bislag-	21 27.270.100.54.05.07	System
ical information Storage Systems —Ames	21-67-370-133-34-03-67	Injury and Recovery in the Rat. Dog. Guinea Pig. and Hi-
-10-87-878-100-52-83-03 Support of A Computer Technology Center for Research on MANO Computers		bernsting Mommals —Amas
21-07-070-100-52-04-01 Learning and Disprimination of Probability Schedule	10-87-676-100-54-03-93	Support of White Mountain Alpine Research Station &
21-57-679-163-52-64-92 Environmental Determinants of Behavior —Amos		Study of the Physiciany of Matural High Altitude Riber- nating Animals —Hdat
16-87-870-160-52-04-63 Circadian Rhythms in Man Under Controlled Environmental	10.97.970.100.53.05.14	nating Animals —Hdat Utilization of Bio-electric Potentials —Hdat
Conditions —Hidat	10-07-070-100-04-03-11	otherwise of pro-closure resembles
21-57-670-100-52-04-03 Control of Complex Behavior in Infra-Numan Organisms 21-87-870-100-52-04-05 Development of an Empirical Calculus of Reinforcement	55 Exabialagy Su	
ValueAmes	10-97-970-100-55-01-01	Studies of Extremely small self-replicating Systems—Hdat
1,000	16-07-879-109-55-01-03	Studies on the Hill Reaction Activity of Soluble Chlore- niest Extracts —Hdgt
54 Environmental Biology Sub-program	10-87-870-109-55-01-04	
18-87-878-100-54-01-03 Study on Effect of Weightlessness on Photosynthesis		Synthesis of Protein Microspheres to Serve as A Cell
10:67-870-100-54-01-04 Program of Research in Space Cenetics — Midot 53:67-670-100-54-01-04 Tissue Equivalent Bosimator Feasibility Study — JPL		Model for Research on the Origin of Life, etc. —Ames
10-87-070-100-54-01-05 Study of the Use of Fungal Luminescence as a Physiologi-	10-87-970-100-55-01-03	Microspectrophotometry of Pigments & Organic molecules
cal Index —Hidat	21-87-870-103-55-01-38	Chemistry of Formation of Biologically-significant Mole- cyles Under Primitive Earth and Extraterrestrial Conditions
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10-07-070-4-0-0-4-07 End dolerates instrumentation ——inct 10-07-070-4-01-60 A Viorkship on Dictelemetry —Edat	21-67-070-100-55-01-00	Physica-Chemical Properties of Artificial Multilaver Systems
21-87-870-180-54-02-01 Effects of Low Magnetic Fields on Living Material —Ames	16-87-870-188-85-81-19	Cynamic Systems Response of the Performance Characteristics of Some Major Biophysical Systems of Interest
10-37-670-100-54-02-02 Effects of Very Strong Magnetic Fields and of Magnet	21-87-870-103-55-01-10	Effects of Extratorrestrial Conditions on the Metabolism
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Development, and Training

05 STUDIES OF BIOLOGICAL MATERIALS & SYSTEMS FOR USE IN

21-87-870-100-54-05-06 Incorporation and Metabolism of Nitrogen by Plants

SPACE TASK AREA

21-87-870-100-54-05-07 Comparative Effects of Protons and X-rays on Intestinal Injury and Recovery in the Rat, Dog. Cuinea Pig. and Ribernating Mammals

—Ames

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55 Exobiology Sub	HEORETICAL BIOLOGY TASK AREA
21-87-870-100-55-01-04	Synthesis of Protein Microspheres to Serve as A Cell
	Model for Research on the Origin of Life, etcAmes
21-87-870-100-55-01-06	Chemistry of Formation of Biologically-significant Mole-
	cules Under Primitive Earth and Extraterrestrial Conditions
21-87-870-100-55-01-07	Properties of Monolayers of Cell Membrane Components
	at Liquid Interfoces -Ames
21-87-870-100-55-01-08	Physico-Chemical Properties of Artificial Multilayer Systems
21-87-870-100-55-01-10	Effects of Extraterrestrial Conditions on the Metabolism
21.07.070.100.33-01.10	of Tissue Maintained in Culture —Ames
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21-87-870-100-55-01-11	Factors Controlling the Formation of Hereditary Materials
21-87-670-100-55-01-13	A Study of Molecular Structures and Reactions Occurring
	in Biological Systems Irradiated with Ultraviolet Light
21-87-870-100-55-01-14	Study of Smallest Reglicating Units of Heredity —Ames
21-87-870-100-55-01-15	The Mechanism of Radiation-Induced Delay of Cell Division
21-87-870-100-55-01-16	Radiation Effects on Photosynthetic Organisms -Ames
21-87-870-100-55-01-17	Lipid Involvement in Photosynthesis -Ames
21-87-870-100-55-01-18	Structure of Nucleic Acids of Viruses -Ames
02 INSTRUMENTATION	FOR DETECTION OF EXTRATERRESTRIAL LIFE &
•=	POUNDS TASK AREA
21-87-870-100-55-02-05	Life Detection in Planetary Models and Simulators -Ames
21-87-870-100-55-02-12	Life Detection Devices Ames
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21-87-870-100-55-04-01	Provide Laboratory and Suitable Technology for Detailed
	Analysis of Returned Extraterrestrial Samples -Ames
21-87-870-100-55-04-03	Analysis of Bio-organic Materials of Extraterrestrial Origin
21-87-870-100-55-04-19	Isolation of Viruses and Bacteria —Ames